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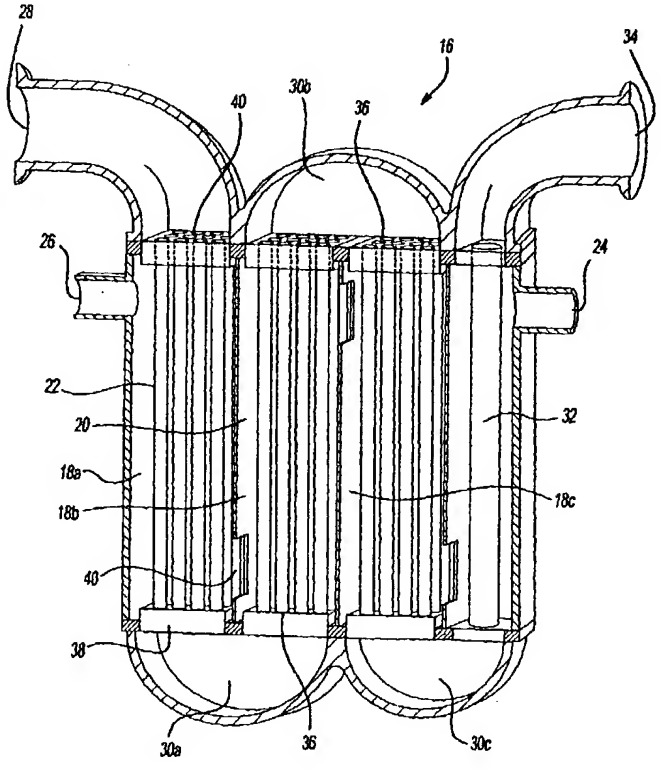
[Continued on next page]

(54) Title: MULTIPLE PACK EGR COOLER



(57) Abstract: A cooler in an EGR system condenses unburned fuel in exhaust gas prior to reintroduction in the engine. The cooler is separated into a plurality of packs each including a plurality of tubes contained within a shell section. The plurality of tubes contain the exhaust fluid which exchanges heat with a cooling fluid in the shell section. As the exhaust fluid passes through the plurality of tubes in each of the packs, the exhaust fluid exchanges heat with the cooling fluid and condenses. The exhaust fluid flows through a fluid connector when traveling from one pack to another pack. The exhaust fluid is then directed out of the cooler for recirculation back into the engine.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:
— *with international search report*
— *with amended claims*

MULTIPLE PACK EGR COOLER

BACKGROUND OF THE INVENTION

The present invention relates generally to a multiple pack exhaust gas recirculation (EGR) cooler for use in a combustion engine.

EGR systems are utilized to improve engine efficiency and to reduce the harmful effects of exhaust gas on the environment. As an engine burns fuel, the engine produces an exhaust gas which contains unburned fuel and other impurities. An EGR system redirects the exhaust gas back through the engine to burn any unburned fuel remaining in the exhaust gas. By reburning the exhaust gas before it is released into the environment, the harmful effects of the exhaust gas on the atmosphere are reduced, enabling the vehicle to meet government emission standards.

EGR systems typically include a valve and a cooler. The valve regulates the amount of exhaust gas which is introduced back into the engine. The cooler cools the exhaust gas to a specified temperature to condense the unburned fuel prior to being introduced back into the engine.

The cooler of an EGR system is usually either a plate heat exchanger or a shell and tube heat exchanger. A plate heat exchanger is generally smaller than a shell and tube heat exchanger having equivalent performance abilities. As a plate heat exchanger is smaller, it is more commonly used when there are spacial constraints. As prior art shell and tube heat exchangers are generally larger, a drawback is that they cannot be used if there are spacial constraints.

Hence, there is a need in the art for a shell and tube heat exchanger for use in an EGR cooler of a combustion engine which is smaller in size without a decrease in performance ability.

SUMMARY OF THE INVENTION

An exhaust gas recirculation (EGR) system is employed to redirect exhaust gas to a combustion engine to burn any remaining fuel in the exhaust gas. The EGR system includes a cooler which condenses any unburned fuel remaining in the exhaust gas prior to being introduced back into the engine. The cooler is separated into a

plurality of packs each including a plurality of helical tubes contained within a shell section. In one example, the tubes are helical shaped to increase the surface area between the hot exhaust fluid in the tubes and the cooling fluid in the shell section. The helical shape of the tubes also increases the turbulence of the exhaust fluid flowing in the tubes. The tubes are such as are available under the trademark Flexfin™.

As the exhaust fluid passes through the tubes in the cooler, the exhaust fluid exchanges heat with the cooling fluid in the shell section and condenses. In one example, the cooler includes three packs. The exhaust fluid flows through the plurality of tubes in the first pack and exchanges heat with the cooling fluid. After entering a first reversing chamber, the exhaust fluid is directed into the second pack. The exhaust fluid flows through the plurality of tubes in the second pack in a direction opposite to the flow of the exhaust fluid in the first pack. The exhaust fluid enters a second reversing chamber and is directed into the plurality of tubes in the third pack. The exhaust fluid exchanges heat with the cooling fluid in the third pack and enters the third reversing chamber for entry in an exit tube for recirculation back into the engine.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 illustrates a schematic view of an EGR system;

Figure 2 illustrates a cross-sectional view of the EGR cooler of the present invention using a shell and tube heat exchanger in multiple packs; and

Figure 3 illustrates a perspective view of a section of one of the tubes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 schematically represents of an exhaust gas recirculation (EGR) system 10 used in a combustion engine 12. As the engine 12 burns fuel, an exhaust gas containing unburned fuel and other impurities is produced. The EGR system 10 redirects the exhaust gas back to the engine 12 to burn any fuel remaining in the exhaust gas.

A valve 14 regulates the quantity of exhaust gas in the EGR system 10 introduced back into the engine 12. After passing through the valve 14, the exhaust gas enters a cooler 16 for cooling to a specified temperature. Unburned fuel remaining in the exhaust gas is condensed in the cooler 16 prior to being introduced back into the engine 12.

Figure 2 schematically illustrates the cooler 16 of the present invention. The cooler 16 is separated into three packs 18a, 18b and 18c, each including a plurality of tubes 22 contained within a shell section 20. The exhaust fluid in the plurality of tubes 22 exchanges heat with cooling fluid in the shell section 20. The cooling fluid flows between packs 18 in the cooler 16 through openings 40 between the packs 18. The cooling fluid is preferably a mixture of water and glycol. However, it is to be understood that the plurality of tubes 22 can contain the cooling fluid and the shell section 20 can contain the exhaust fluid.

The cooling fluid enters the shell section 20 through a cooling fluid inlet 24. The cooling fluid flows around the plurality of tubes 22 and exchanges heat with and cools the exhaust fluid in the tubes 22. The cooling fluid exits the cooler 16 through a cooling fluid outlet 26.

Hot exhaust fluid from the engine 12 enters the cooler 16 through an exhaust fluid inlet 28 and flows through the plurality of tubes 22 in the pack 18a. In one example, as illustrated in Figure 3, the plurality of tubes 22 are helical shaped to increase the surface area of the tubes 22 and the heat transfer surface area between the exhaust fluid and the cooling fluid. The helical shaped tubes 22 are such as are available under the trademark Flexfin™. The helical shape of the tubes 22 also creates turbulence in the exhaust fluid, further increasing heat transfer between the exhaust fluid and the cooling fluid.

Returning to Figure 2, the exhaust fluid exchanges heat with the cooling fluid and condenses as it passes through the cooler 16. As the exhaust fluid flows through the plurality of tubes 22 in the first pack 18a, the exhaust fluid exchanges heat with the cooling fluid in the shell section 20. The exhaust fluid then enters a first reversing chamber 30a, which directs the exhaust fluid into the plurality of tubes 22 in the second pack 18b. In the second pack 18b, the exhaust fluid flows through the plurality of tubes 22 in a direction opposite to the flow of the exhaust fluid in the first pack 18a

and continues to lose heat to the cooling fluid. The exhaust fluid then enters a second reversing chamber 30b and is directed into the plurality of tubes 22 in the third pack 18c. The exhaust fluid exchanges heat with the cooling fluid in the third pack 18a and enters the third reversing chamber 30c. The exhaust fluid then flows through an exit tube 32 and is directed out of the cooler 16 through the exhaust fluid outlet 34 for recirculation back into the engine 12.

Each pack 18 further includes two endplates 38 having a plurality of holes 40 sized and shaped to receive an end 36 of one of the plurality of tubes 22. The number of holes 40 in each endplate 38 equals the number of tubes 22 employed in each pack 18. The ends 36 of each tube 22 are each inserted into one of the holes 40 and secured. In one example, the ends 36 of the tubes 22 are secured in the holes 40 of the endplate 38 by welding, although it is to be understood that other types of attachment are possible. Although the two endplates 36 for any given pack 18 are identical and include the same number of holes 40, the number of holes 40 in the endplates 36 in another pack 18 can be different.

Although three packs 18 have been illustrated and described, it is to be understood that any number of packs 18 can be employed in the cooler 16 according to customer specifications. For example, the cooler 16 can include two packs 18, or even one pack 18. A worker skilled in the art would know how many packs 18 to employ.

There are many advantages to employing the EGR cooler 16 of the present invention. For one, as the plurality of tubes 22 are preferably helical shaped, each tube 22 has a greater surface area for a given length than a cylindrical tube, increasing the heat transfer surface area. As the heat transfer area is increased, the length of the tubes 22 can be reduced, allowing for a smaller cooler 16. Additionally, as the packs 18 of the cooler 16 are stacked, the cooler 16 occupies a smaller amount of space than the cooler of the prior art.

The foregoing description is only exemplary of the principles of the invention. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, so that one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be

practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.

CLAIMS

1. A cooler for an exhaust gas recirculation system comprising:

a plurality of tubes to contain one of an exhaust fluid and a cooling fluid, said plurality of tubes separated into a plurality of packs; and

a shell portion enclosing said plurality of tubes to contain the other of said exhaust fluid and said cooling fluid, said exhaust fluid and said cooling fluid exchanging heat therebetween.

2. The cooler as recited in claim 1 wherein said exhaust fluid is contained in said plurality of tubes and said cooling fluid is contained in said shell portion.

3. The cooler as recited in claim 2 wherein said exhaust fluid passes through each of said plurality of packs consecutively.

4. The cooler as recited in claim 3 wherein said exhaust fluid travels between a first pack and a second pack through a first fluid connector positioned between said first pack in which said exhaust fluid flows in a first direction and said second pack in which said exhaust fluid travels in a second direction opposite to said first direction, said exhaust fluid flowing through said first connector to reverse said exhaust fluid from said first direction to said second direction.

5. The cooler as recited in claim 4 wherein said cooler further includes a third pack, and said exhaust fluid travels between said second pack and said third pack through a second fluid connector positioned between said second pack in which said exhaust fluid flows in said second direction and said third pack in which said exhaust fluid travels in a third direction opposite to said second direction, said exhaust fluid flowing through said second connector to reverse said exhaust fluid from said second direction to said third direction.

6. The cooler as recited in claim 5 wherein said cooler further includes an exit tube, and said exhaust fluid travels between said third pack and said exit tube through a third fluid connector positioned between said third pack in which said exhaust fluid flows in said third direction and said exit tube in which said exhaust fluid travels in a fourth direction opposite to said third direction, said exhaust fluid flowing through said third connector to reverse said exhaust fluid from said third direction to said fourth direction.

7. The cooler as recited in claim 1 wherein each of said pack of said cooler further include a first end plate and a second end plate each having a plurality of holes, and a first end of each of said plurality of tubes is received in said plurality of holes in said first end plate and an opposing second end of each of said plurality of tubes is received in said plurality of holes in said second end plate.

8. The cooler as recited in claim 1 wherein said plurality of tubes are helical.

9. An EGR system comprising:

an engine which burns fuel to produce an exhaust fluid;

a valve to regulate a quantity of said exhaust fluid introduced in a cooler; and

said cooler including a plurality of tubes to contain an exhaust fluid, said plurality of tubes separated into a plurality of packs and further including a shell portion enclosing said plurality of tubes to contain a cooling fluid that exchanges heat with said exhaust fluid, said cooled exhaust fluid exiting said cooler for return to said engine.

10. The system as recited in claim 9 wherein said exhaust fluid passes through each of said plurality of packs consecutively.

11. The system as recited in claim 10 wherein said exhaust fluid travels between a first pack and a second pack through a first fluid connector positioned between said first pack in which said exhaust fluid flows in a first direction and said second pack in which said exhaust fluid travels in a second direction opposite to said first direction, said exhaust fluid flowing through said first connector to reverse said exhaust fluid from said first direction to said second direction.

12. The system as recited in claim 11 wherein said cooler further includes a third pack, and said exhaust fluid travels between said second pack and said third pack through a second fluid connector positioned between said second pack in which said exhaust fluid flows in said second direction and said third pack in which said exhaust fluid travels in a third direction opposite to said second direction, said exhaust fluid flowing through said second connector to reverse said exhaust fluid from said second direction to said third direction.

13. The system as recited in claim 12 wherein said cooler further includes an exit tube, and said exhaust fluid travels between said third pack and said exit tube through a third fluid connector positioned between said third pack in which said exhaust fluid flows in said third direction and said exit tube in which said exhaust fluid travels in a fourth direction opposite to said third direction, said exhaust fluid flowing through said third connector to reverse said exhaust fluid from said third direction to said fourth direction.

14. The system as recited in claim 9 wherein each of said packs of said cooler further include a first end plate and a second end plate each having a plurality of holes, and a first end of each of said plurality of tubes is received in said plurality of holes in said first end plate and an opposing second end of each of said plurality of tubes is received in said plurality of holes in said second end plate.

15. The system as recited in claim 9 wherein said plurality of tubes are helical.

16. A cooler for an exhaust gas recirculation system comprising:

a plurality of helical tubes to contain one of an exhaust fluid and a cooling fluid, said plurality of tubes separated into at least one pack; and

a shell portion enclosing said plurality of tubes to contain the other of said exhaust fluid and said cooling fluid, said exhaust fluid and said cooling fluid exchanging heat therebetween.

17. A cooler for an exhaust gas recirculation system comprising:

a plurality of helical tubes to contain an exhaust fluid separated into a plurality of packs, said exhaust fluid passing through each of said plurality of packs consecutively and said exhaust fluid travels between a first pack and a second pack through a first fluid connector positioned between said first pack in which said exhaust fluid flows in a first direction and said second pack in which said exhaust fluid travels in a second direction opposite to said first direction, said exhaust fluid flowing through said first connector to reverse said exhaust fluid from said first direction to said second direction; and

a shell portion enclosing said plurality of tubes to contain a cooling fluid that exchanges heat with said exhaust fluid.

18. The cooler as recited in claim 17 wherein said cooler further includes a third pack, and said exhaust fluid travels between said second pack and said third pack through a second fluid connector positioned between said second pack in which said exhaust fluid flows in said second direction and said third pack in which said exhaust fluid travels in a third direction opposite to said second direction, said exhaust fluid flowing through said second connector to reverse said exhaust fluid from said second direction to said third direction.

19. The cooler as recited in claim 18 wherein said cooler further includes an exit tube, and said exhaust fluid travels between said third pack and said exit tube through a third fluid connector positioned between said third pack in which said exhaust fluid flows in said third direction and said exit tube in which said exhaust fluid travels in a fourth direction opposite to said third direction, said exhaust fluid flowing through said third connector to reverse said exhaust fluid from said third direction to said fourth direction.

20. The cooler as recited in claim 17 wherein each of said packs of said cooler further include a first end plate and a second end plate each having a plurality of holes, and a first end of each of said plurality of tubes is received in said plurality of holes in said first end plate and an opposing second end of each of said plurality of tubes is received in said plurality of holes in said second end plate.

21. A method for cooling an exhaust fluid comprising the steps of:

providing a plurality of tubes to contain an exhaust fluid separated into a plurality of packs;

providing a shell portion enclosing said plurality of tubes to contain a cooling fluid; and

exchanging heat between said exhaust fluid in said plurality of tubes and said cooling fluid in said shell portion, said exhaust fluid flowing through each of said plurality of packs consecutively.

AMENDED CLAIMS

[received by the International Bureau on 20 January 2003 (20.01.03);
original claims 1 and 21 replaced by new claims 1 and 21;
remaining claims unchanged (2 pages)]

1. A cooler for an exhaust gas recirculation system comprising:

a plurality of tubes to contain one of an exhaust fluid and a cooling fluid, said plurality of tubes separated into a plurality of packs, each of said plurality of tubes having a uniform cross-sectional area; and

a shell portion enclosing said plurality of tubes to contain the other of said exhaust fluid and said cooling fluid, said exhaust fluid and said cooling fluid exchanging heat therebetween.

2. The cooler as recited in claim 1 wherein said exhaust fluid is contained in said plurality of tubes and said cooling fluid is contained in said shell portion.

3. The cooler as recited in claim 2 wherein said exhaust fluid passes through each of said plurality of packs consecutively.

4. The cooler as recited in claim 3 wherein said exhaust fluid travels between a first pack and a second pack through a first fluid connector positioned between said first pack in which said exhaust fluid flows in a first direction and said second pack in which said exhaust fluid travels in a second direction opposite to said first direction, said exhaust fluid flowing through said first connector to reverse said exhaust fluid from said first direction to said second direction.

5. The cooler as recited in claim 4 wherein said cooler further includes a third pack, and said exhaust fluid travels between said second pack and said third pack through a second fluid connector positioned between said second pack in which said exhaust fluid flows in said second direction and said third pack in which said exhaust fluid travels in a third direction opposite to said second direction, said exhaust fluid flowing through said second connector to reverse said exhaust fluid from said second direction to said third direction.

19. The cooler as recited in claim 18 wherein said cooler further includes an exit tube, and said exhaust fluid travels between said third pack and said exit tube through a third fluid connector positioned between said third pack in which said exhaust fluid flows in said third direction and said exit tube in which said exhaust fluid travels in a fourth direction opposite to said third direction, said exhaust fluid flowing through said third connector to reverse said exhaust fluid from said third direction to said fourth direction.

20. The cooler as recited in claim 17 wherein each of said packs of said cooler further include a first end plate and a second end plate each having a plurality of holes, and a first end of each of said plurality of tubes is received in said plurality of holes in said first end plate and an opposing second end of each of said plurality of tubes is received in said plurality of holes in said second end plate.

21. A method for cooling an exhaust fluid comprising the steps of:

providing a plurality of tubes to contain an exhaust fluid separated into a plurality of packs, each of said plurality of tubes having a uniform cross-sectional area;

providing a shell portion enclosing said plurality of tubes to contain a cooling fluid; and

exchanging heat between said exhaust fluid in said plurality of tubes and said cooling fluid in said shell portion, said exhaust fluid flowing through each of said plurality of packs consecutively.

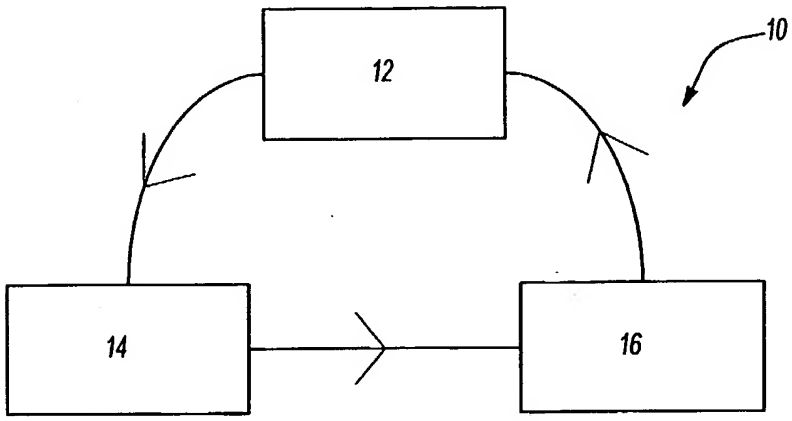

Fig-1

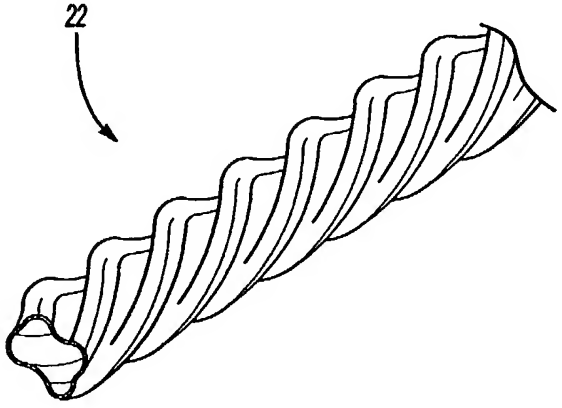

Fig-3

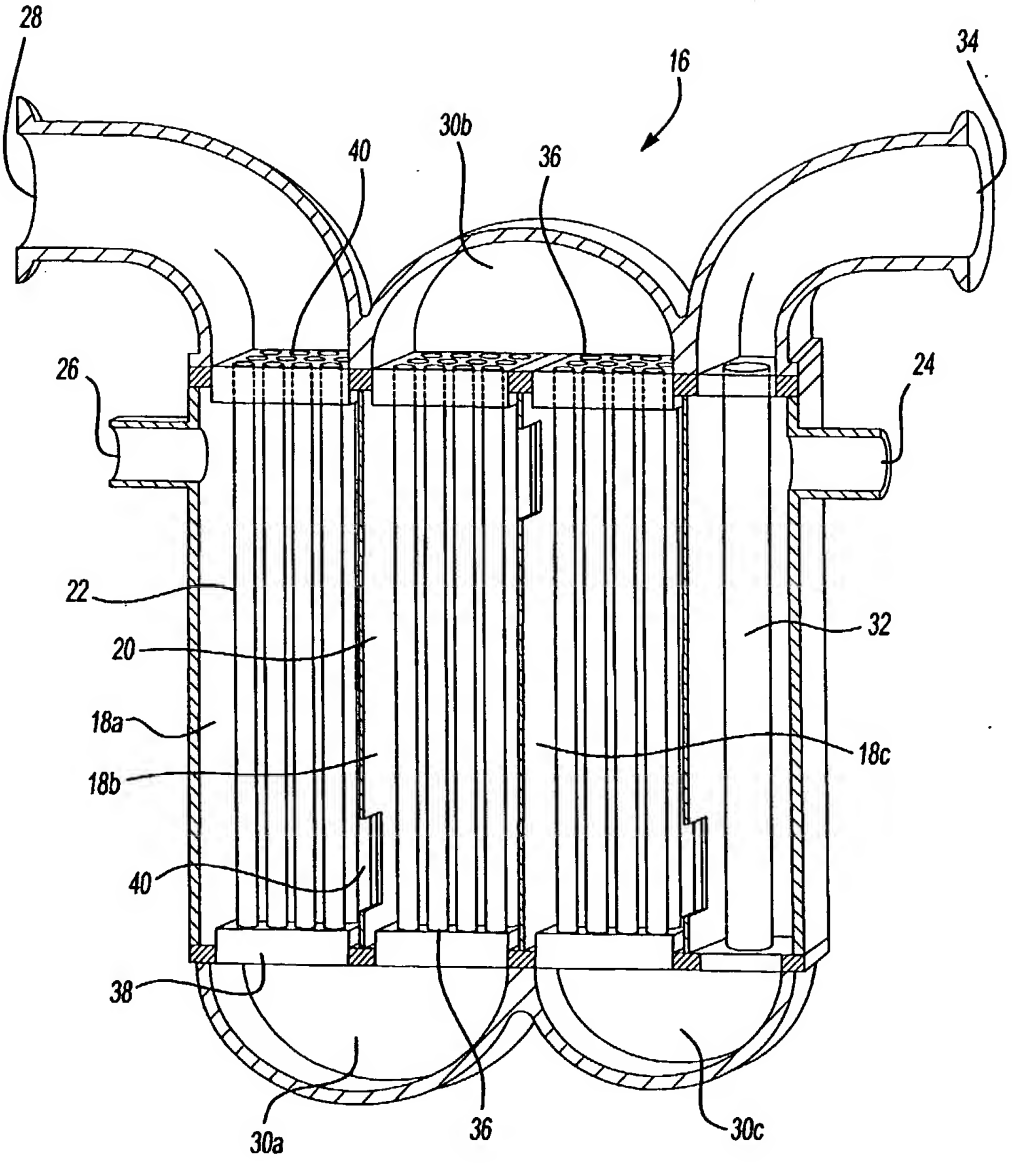

Fig-2

INTERNATIONAL SEARCH REPORT

	onal Application No
	PCT/US 02/29891

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02M25/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02M F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 16, 8 May 2001 (2001-05-08) & JP 2001 027157 A (MITSUBISHI MOTORS CORP), 30 January 2001 (2001-01-30)	1-4,7,21
Y	abstract; figures 4,5	8-11, 14-17
Y	US 4 134 377 A (BAMSEY ROBERT G ET AL) 16 January 1979 (1979-01-16) abstract; figure 1	9-11,14
Y	DE 93 21 031 U (FRIEDRICH AMBS GMBH & CO KG AP) 16 November 1995 (1995-11-16) claim 1; figures 1,2	8,15-17

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
6 November 2002	18/11/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tatus, W

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/29891

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 13, 30 November 1999 (1999-11-30) & JP 11 237192 A (TENNEX CORP), 31 August 1999 (1999-08-31) abstract; figure 1	1,2
A	EP 1 096 131 A (SENIOR FLEXONICS AUTOMOTIVE LT) 2 May 2001 (2001-05-02) paragraph '0040! - paragraph '0053!	1,2,9, 16,17

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

In ional Application No
PCT/US 02/29891

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2001027157 A	30-01-2001	NONE	
US 4134377 A	16-01-1979	BR 7806381 A	24-04-1979
		CA 1092915 A1	06-01-1981
		DE 2842653 A1	12-04-1979
		FR 2404741 A1	27-04-1979
		GB 2043770 A ,B	08-10-1980
DE 9321031 U	16-11-1995	DE 4343405 A1	22-06-1995
		DE 9321031 U1	16-11-1995
JP 11237192 7 A		NONE	
EP 1096131 A	02-05-2001	EP 1096131 A1	02-05-2001
		DE 69900303 D1	25-10-2001
		DE 69900303 T2	04-07-2002
		ES 2163317 T3	16-01-2002
		JP 2001159377 A	12-06-2001
		US 6460520 B1	08-10-2002